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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04B 7/06	A1	(11) International Publication Number: WO 99/59263 (43) International Publication Date: 18 November 1999 (18.11.99)

(21) International Application Number: PCT/KR99/00238

(22) International Filing Date: 13 May 1999 (13.05.99)

(30) Priority Data:
1998/17278 13 May 1998 (13.05.98) KR
1998/28982 14 July 1998 (14.07.98) KR

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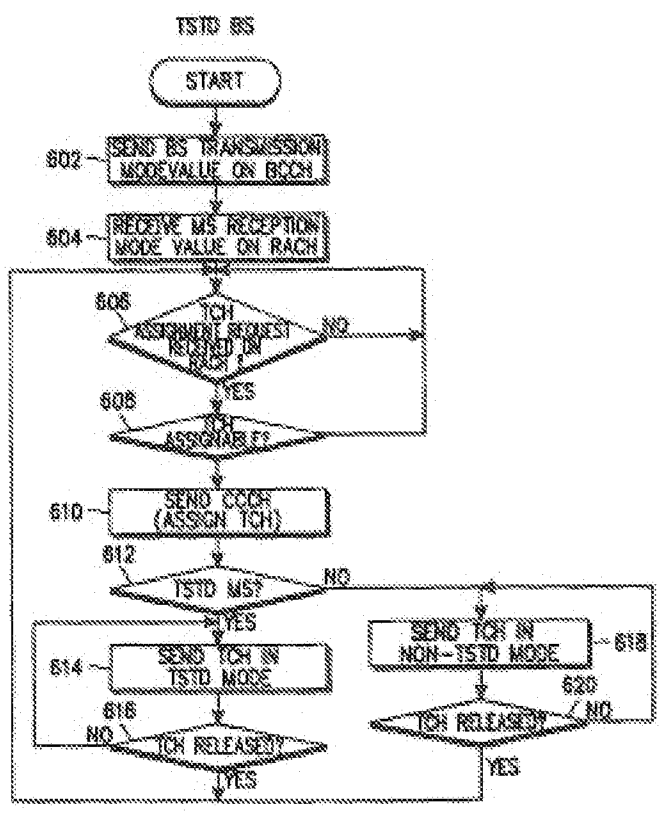
(81) Designated States: AU, BR, CA, CN, JP, RU, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: TIME-SWITCHED TRANSMISSION DIVERSITY (TSTD) DEVICE AND CONTROLLING METHOD THEREOF IN MOBILE COMMUNICATION SYSTEM

(57) Abstract

There is provided a transmission diversity controlling method in a mobile communication system including a base station which transmits forward common and dedicated channel data through at least two antennas with transmission diversity. The base station sends a message indicating a TSTD (Time-Switched Transmission Diversity)/non TSTD transmission mode through an antenna to a plurality of mobile stations in the coverage area of the base station. Then, each mobile station analyses the message received from the base station and sets its reception mode to a TSTD/non-TSTD mode according to the transmission mode.



TIME-SWITCHED TRANSMISSION DIVERSITY (TSTD) DEVICE AND CONTROLLING METHOD THEREOF IN MOBILE COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of communication systems, and particularly to a transmitting/receiving device with a time-switched transmission diversity function and a controlling method thereof in a mobile communication system.(For better understanding of the present invention, see Korea Application No. 1998-5526, Korea Application No. 1998-17277, and Korea Application No. 1998-17280)

2. Description of the Related Art

A base station (BS) and a mobile station (MS) communicate data with each other through their single antennas in most mobile communication systems. When a signal-fading phenomenon occurs, a plurality of data groups are damaged, resulting in a serious degradation of communication quality. This problem can be solved by use of a transmission diversity scheme in which data is transmitted through at least two transmission antennas. That is, the transmission diversity scheme can increase data transmission/reception performance in a mobile communication system under a signal fading environment.

In addition to using a transmission diversity scheme, a reception diversity scheme can be utilized on the reverse link by installing a plurality of reception antennas in a BS so that the BS can receive a signal from an MS on a reverse link with good reception performance. On a forward link, the BS can transmit a signal to the MS through multiple antennas. For communication with the BS, the MS may employ one of these approaches; a transmission diversity scheme using a plurality of transmission antennas with a single reception antenna, a reception diversity scheme requiring a plurality of reception antennas, or a combination of the transmission and reception diversity schemes.

Reception diversity on the forward link, however, is not viable because the mobile terminal is small. That is, using a plurality of reception antennas for the mobile terminal results in a small diversity gain due to the limited distance between antennas. Furthermore, the mobile terminal should be equipped with separately procured devices for receiving forward link signals and transmitting reverse link signals through corresponding antennas. Therefore, for the reasons stated, the reception diversity scheme is disadvantageous in terms of the size and cost of the mobile terminal. Therefore, the transmission diversity scheme is generally used for the forward link in a base station.

SUMMARY OF THE INVENTION

The method of the present invention is generally referred to as time switched transmission diversity (TSTD) and is applied to signal transmissions on a forward link from a BS to an MS in a CDMA (Code Division Multiple Access) mobile communication system. The TSTD scheme increases transmission efficiency by transmitting signals through at least two antennas which are alternately switched in the BS. Since a TSTD transmitting/receiving device

increases device complexity as well as performance in comparison with a conventional single-antenna transmitting/receiving device, it is expected that the inventive TSTD device and a non-TSTD (i.e., prior art) device will coexist. Therefore, to ensure reliable TSTD transmission/reception, a BS and an MS should support a TSTD mode, and have controllers and controlling procedures for determining whether to use the TSTD mode prior to transmission/reception of user data and signalling data on a dedicated channel. The controlling procedures are necessary to allow a non-TSTD MS to compatibly communicate with a TSTD BS.

For a BS to transmit modulated data in a TSTD mode through at least two antennas and for an MS to receive the TSTD data from the BS, their operational modes should be set up. For proper operation, if the BS is to transmit data in the TSTD mode, the MS detects the transmission mode of the BS by analysing a message received from the BS and sets its reception mode to a TSTD or non-TSTD mode according to the detected transmission mode, for data reception.

It is therefore an object of the present invention to provide a device for communicating data between a BS and an MS which support TSTD as an optional or requisite function and a controlling method thereof.

Another object of the present invention is to provide a device for setting transmission/reception modes of a BS and an MS which support TSTD as an optional or requisite function and a controlling method thereof.

A further object of the present invention is to provide a device and method of estimating the channel status of TSTD signals received from a TSTD BS through a plurality of transmit antennas.

A still further object of the present invention is to provide a method of setting a TSTD mode between a BS and an MS which support TSTD as an optional or requisite function.

Still another object of the present invention is to provide a method of operating forward common and dedicated channels between a BS and an MS which are support TSTD as an optional function in a mobile communication system.

A yet another object of the present invention is to provide a device and method for operating forward common and dedicated channels in the case where BSs and MSs which support TSTD as an optional or requisite function coexist with Bss and MSs which do not support TSTD in a mobile communication system.

To achieve the above objects, there is provided a transmission diversity controlling method in a mobile communication system including a base station which transmits forward common and dedicated channel data through at least two antennas with transmission diversity. The base station sends a message indicating a TSTD/non-TSTD transmission mode through an antenna to a plurality of mobile stations in the coverage area of the base station. Then, each mobile station analyses the message received from the base station and sets its reception mode to a TSTD/non-TSTD mode according to the transmission mode.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with

reference to the attached drawings in which:

FIGs. 1A, 1B and 1C is an illustration describing a TSTD operation in a mobile communication system according to an embodiment of the present invention;

FIG. 2 is a block diagram of a TSTD device which is a component of a BS and an MS in a mobile communication system utilizing TSTD methods according to an embodiment of the present invention;

FIG. 3 is a block diagram of a TSTD transmitter in the BS for transmitting signals through two antennas according to an embodiment of the present invention;

FIG. 4 is a block diagram of a TSTD receiver in the MS for receiving a TSTD signal according to an embodiment of the present invention;

FIG. 5 illustrates the exchange of messages for controlling a TSTD mode between the BS and the MS according to an embodiment of the present invention;

FIG. 6 is a flowchart of an MS operation for setting a reception mode by exchanging messages with the MS and receiving traffic channel data;

FIG. 7 is a flowchart of a BS operation for setting a transmission mode by exchanging messages with the MS and transmitting traffic channel data;

FIG. 8A illustrates the format of a broadcast message sent to a plurality of MSs by a BS;

FIG. 8B illustrates the format of an access message sent to a BS by an MS; and

FIG. 8C illustrates the format of a common control channel (CCCH) message sent to an MS by a BS.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described in detail with reference to the attached drawings. It is to be noted that a detailed description of a known function or structure of the present invention will be omitted if it is deemed to obscure the subject matter of the present invention.

A detailed description of transmission and reception control message processes for a BS transmitter and an MS receiver to transmit and receive TSTD traffic channel data will be provided.

It should be appreciated with respect to the following description that a forward common channel (e.g., common control channel and common traffic channel) is a channel which can be received by all MSs in a cell, and a forward dedicated channel (e.g., dedicated control channel and dedicated traffic channel) is a channel which can be received by only one specific MS.

The present invention is intended to provide a TSTD device and method in a mobile communication system in which a BS selects one of at least two transmission antennas in time switching to send a common and/or dedicated channel signal according to a switching pattern control signal and an MS receives the TSTD signal.

The present invention is also directed to the operation of the forward common and dedicated channels when a mobile communication system supports the TSTD function as optional or requisite.

If TSTD is supported as a requisite function, all BSs and MSs in the system can communicate data with TSTD. Hence, TSTD can be applied to the forward common and dedicated channels. More specifically, TSTD is

necessarily applied to the forward common channels, and flexibly applied to the forward dedicated channels. The forward dedicated channels are communicated in a TSTD mode in a normal state but in a non-TSTD mode during a handoff or according to the status of a BS or an MS.

If TSTD is supported as an optional function, TSTD BSs and MSs may coexist with non-TSTD BSs and MSs in the system. In this case, TSTD can be applied to the forward common and dedicated channels in many ways. Since the forward common channel is shared by all MSs in a cell, an MS should be capable of receiving a TSTD signal from a BS if the next generation mobile communication standard provides that the BS should support the TSTD function. In the case of the forward dedicated channel, TSTD is applied if both a BS and an MS can support TSTD and is released when the BS or the MS considers non-TSTD mode communication necessary as in a handoff. If at least one of the BS and the MS does not support the TSTD function, TSTD cannot be applied to the forward dedicated channel.

A description of operation of the forward common and dedicated channels between a BS having the TSTD function as optional and an MS having the TSTD function as requisite will precede a description of operation of the forward common and dedicated channels between a BS and an MS which have the TSTD function as requisite. Since reception of a TSTD signal from a BS indicates reception of signals from different paths according to a TSTD transmission pattern of the BS, it is preferable to set a reception pattern to be the same as the transmission pattern and estimate a channel.

FIGs. 1A and 1B describe a TSTD operation in a mobile communication system having TSTD as an optional function according to an embodiment of the

present invention. FIG. 1A illustrates channel support/non-support for the situation where the BS supports TSTD, and FIG. 1B illustrates channel support/non-support for the situation where the BS does not support TSTD. FIGs. 1A and 1B show that application of TSTD to forward channels including a BCCH (Broadcast Control Channel), a CCCH (Common Control Channel), and a TCH (Traffic Channel) depends upon whether a BS and an MS support TSTD or not. Shaded blocks indicate those channels which support TSTD. For example, referring to FIG. 1A, it is shown that the TCH channel supports when both the BS and MS support TSTD.

The forward channels, briefly described above, are defined as follows. BCCH is a common channel on which a BS broadcasts the same information to a plurality of MSs, the CCCH is a common channel on which a BS sends a specific MS a paging message, a channel assignment message, and the like, and the TCH is a dedicated channel on which a BS sends a specific MS user information or signalling information. An RACH (Random Access Channel) (not shown) is a reverse access channel on which an MS transmits data to a BS.

In the case where TSTD BSs and MSs coexist with non-TSTD BSs and MSs, the transmission mode of each transmission channel (i.e., BCCH, CCCH, TCH) for a BS is set according to the operational modes of the BS and an MS, as described in Table 1:

(1) when both the BS and the MS support TSTD, TSTD is applied to a forward BCCH. Though TSTD is basically not applied to other common control channels, it can be applied to them during a time period assigned to an MS in a limited way when necessary in the system. TSTD is selectively applied to the forward dedicated channel.

(2) when only the BS can support TSTD, TSTD is not applied to all forward channels.

(3) when only the MS can support TSTD, TSTD is not applied to all forward channels.

(4) when either of the BS and MS cannot support TSTD, TSTD is not applied to all forward channels.

First Embodiment: BS and MS Support TSTD

In accordance with one embodiment of the present invention where both the BS and MS support TSTD (See FIG. 1A, LHS). TSTD is applied to forward channels only if both the BS and the MS support TSTD in a mobile communication system having TSTD as an optional function.

Though the forward BCCH is directed to unspecific MSs in a cell, if all corresponding MSs can receive a TSTD signal, it is preferable that the BS transmit the forward BCCH in TSTD. The forward CCCH, received by a plurality of MSs, is considered a channel temporarily designated as dedicated for transmission of data to a specific MS during a predetermined time period. Therefore, TSTD is selectively applied to the forward CCCH.

A TSTD device for controlling a TSTD operation in a mobile communication system must be incorporated as additional hardware in both a BS 10 and an MS 12 in FIG. 2.

Referring to FIG. 2, the BS 10 is comprised of a BS transmitter 14 for sending a broadcast message, a paging message, and traffic data (voice, data, and signalling) on a BCCH, a CCCH, and a TCH, upon receipt of a control signal from a BS controller , a BS receiver 16 for receiving a message from the MS 12

on an RACH, and a BS controller 18 for transmitting/receiving signals to/from the BS transmitter 14 and the BS receiver 16 and for controlling the operation of the BS 10.

The MS 12 includes an MS receiver 20 for receiving data from the BS transmitter 14 on the BCCH, CCCH, and TCH, an MS transmitter 22 for sending data to the BS receiver 16 on the RACH, and an MS controller 24 for communicating data with the MS receiver 20 and the MS transmitter 22 and controlling data communication with the BS 10.

A TCH transmitter (not shown) located in the BS transmitter 14 is configured to implement transmission diversity , by way of example. TSTD can be applied to other channels under the condition that such a mutual agreement as provided in the communication standard is set between the BS and the MS. A TCH receiver (not shown) in the MS receiver 20 receives a data signal which was sent in a TSTD mode by the BS through a plurality of antennas. The BS controller 18 controls the BS transmitter 14 to send the MS 12 a message on the BCCH, notifying the MS whether the TSTD made is being supported in the BS. Then, the MS 12 sets its reception mode by analysing the BCCH message received from the BS 10. For example, if the transmission mode is TSTD, the MS 12 also sets its reception mode to TSTD, and if the transmission mode is non-TSTD, the MS 12 also sets its reception mode to non-TSTD. When necessary, the MS 12 may send the BS 10 a message on the RACH, notifying whether the MS 12 supports a TSTD mode or not.

Message Exchange Between BS and MS

The message exchange procedure will be described with reference to the first embodiment (Table 1, row 1) where the BS 10 and the MS 12 both support

TSTD. Referring to Table 1, TSTD can be applied to the forward TCH only in the situation where both the BS 10 and the MS 12 support TSTD.

In operation, the BS controller 18 sends the BS transmitter 14 BS transmission mode information. For example, it sends the BS transmitter 14 control data including transmission mode information indicating whether the BCCH transmitter supports a TSTD mode or not, and if the TSTD mode is supported a TSTD pattern is additionally sent by the controller. The BS transmitter 14 sends the MS 12 the control data on the BCCH under the control of the BS controller 18.

The MS receiver 20 analyses the transmission mode information received from the BS 10 on the BCCH. The MS controller 24 analyzes the transmission mode information and sends the MS transmitter 22 reception mode information.. The MS transmitter 22 sends the BS 10 the MS reception mode information on the RACH. The BS receiver 16 sends the BS controller 18 the MS reception mode information received on the RACH, and the BS controller 18 generates a control signal based on both the BS transmission mode information and the MS reception mode information to control the operation of the BS transmitter 14 as shown in FIGs. 1A and 1B.

Meanwhile, the MS controller 24 generates a control signal based on both the MS reception mode information and the BS transmission mode information to control the operation of the MS receiver 20. The BS transmitter 14 sends the MS receiver 20 a message for setting a TCH on the CCCH prior to designation of the TCH. Upon designation of the TCH, the BS transmitter 14 sends the MS receiver 20, user or signalling information on the TCH in a selected transmission mode.

The following description will further assist in understanding the operation of determining a transmission/reception mode by the exchange of call processing messages between the BS 10 and the MS 12.

FIG. 3 is a block diagram of a TSTD transmitter in the BS transmitter 12, for sending a signal through two antennas according to exemplary embodiments of the present invention. In the drawing, a transmission/reception filter is not shown. It is to be appreciated that in alternate embodiments, the number of the antennas may be changed to be more than two. In general, irrespective of the number of antennas use, each antenna uses a different pilot channel (in some cases, pilot symbols transmitted on one antenna at a time are used instead of a pilot channel in a CDMA system).

In FIG. 3, an encoder 102 encodes input user data UD, an interleaver 104 interleaves the channel-encoded data, and a serial-to-parallel converter (SPC) 106 divides the interleaved serial data stream into odd-numbered symbols and even-numbered symbols as an I-channel signal and a Q-channel signal, respectively. A Walsh and PN spreader (hereinafter, referred to as spreader) 108 orthogonally modulates the I- and Q-channel signals by Walsh codes and spreads the orthogonally modulated signals by PN sequences. The spread I- and Q-channel data is separately fed to input terminals of first and second switches 110 and 111 each having first and second output terminals. The first and second output terminals of the first and second switches 110 and 111 are connected to two input terminals of each of first and second modulators 114 and 116 for modulating the I- and Q-channel data by a cosine wave (cos Wct) and a sine wave (sin Wct) at a modulation frequency and adding the resulting data.

The first and second switches 110 and 111 are switched according to a

switching pattern control signal received from a first switch controller 112 to send the I- and Q-channel data received from the spreader 108 through antennas ANT1 and ANT 2 in accordance with the time switching pattern control signal. It is to be appreciated that data is never simultaneously transmitted through ANT1 and ANT2 (See items 113, 144). The switching pattern control signal is generated based on a control signal received from the BS controller 18. The control signal is determined by the BS transmission mode information indicating whether the BS 10 supports a TSTD mode or not, and the message received from the MS 12 on the RACH.

The switching pattern control signal patterns generally may be categorized as follows:

(1) a first switching pattern: the first and second switches 110 and 111 are confined to the antenna ANT1;

(2) a second switching pattern: the first and second switches 110 and 111 are confined to the antenna ANT2;

(3) a third switching pattern: the first and second switches 110 and 111 are switched between the antennas ANT1 and ANT2, starting from the antenna ANT1; and

(4) a fourth switching pattern: the first and second switches 110 and 111 are switched between the antennas ANT1 and ANT2, starting from the antenna ANT2.

The first and second switching patterns are exclusively used in a non-TSTD mode, and the third and fourth switching patterns are exclusively used in a TSTD mode. In the non-TSTD mode, selection between the first and second switching patterns depends on a channel type. In the TSTD mode, selection between the third and fourth switching patterns depend on a TSTD pattern which

will be later described.

FIG. 4 is a block diagram of a TSTD receiver in the MS 12, for receiving a TSTD signal according to an embodiment of the present invention. In FIG. 4, a demodulator 202 demodulates a signal received through a reception antenna by the cosine wave (cos Wct) and the sine wave (sin Wct) and outputs I- and Q-channel data. A complex PN despreader (hereinafter, referred to as despreader) 204 despreads the demodulated I- and Q-channel data. First and second channel correctors 206 and 208 estimate the errors of the I- and Q-channel data and multiply the original reception values by the errors.

The corrected data output from the first and second channel correctors 206 and 208 are selected by a switch 210 which is switched according to a switching pattern control signal generated from a second switch controller 212. The switching pattern control signal is the same as that generated from the TSTD transmitter and determined based on the MS reception mode information and a message received from the BS 10 on the BCCH.

A paralell-to-serial converter (PSC) 214 connected to an output node of the switch 210 converts switchedly input channel-corrected parallel data to serial data. The serial data is deinterleaved by a deinterleaver 216 connected to an output node of the PSC 214. A decoder 218 decodes the deinterleaved data and outputs the decoded data as user data (UD).

FIGs. 5-8 will be briefly described, after which a detailed description will be provided with reference to FIGs. 2-8.

FIG. 5 is a message exchange flow diagram illustrating the exchange of

messages between the BS and the MS for controlling a TSTD mode, FIG. 6 is a flowchart of an MS operation for setting a reception mode by exchanging messages with the BS and receiving a TSTD message, and FIG. 7 is a flowchart of a BS operation for setting a transmission mode by exchanging messages with the MS and sending traffic channel data.

FIG. 8A illustrates the format of a broadcast message transmitted to a plurality of MSs by a BS, FIG. 8B illustrates the format of an access message transmitted to a BS by an MS, and FIG. 8C illustrates the format of a CCCH message transmitted to an MS by a BS.

Referring now to FIGs. 2 to 8C, a detailed description of (1) setting a TSTD mode, and (2) transmission and reception of TSTD data in a mobile communication system having TSTD as an optional function will be provided .

When a mobile communication system having a transmission channel structure as shown in FIG. 2 is operated, the BS controller 18 of the BS 10 controls the BS transmitter 18 to send all the MS receivers 20 in the coverage area of the BS 10 the broadcast message of FIG. 8A on the BCCH as detailed in steps 502 of FIG. 5 and step 602 of FIG. 6. The broadcast message includes a message type, the transmission mode of the BS 10, and other information. The BS transmission mode value indicates whether the BS transmission mode is TSTD or non-TSTD. The BS controller 18 also determines whether the BS receiver 16 has received the reception mode information of the MS 12 on the RACH.

Referring to FIG. 2, if power is turned on in the MS 12 while the BS 10 is operated, the MS controller 24 controls the MS receiver 20 to acquire a pilot

signal or a synchronization providing channel from the BS transmitter 14 and synchronizes its timing to the BS 10, in step 702 of FIG. 7. In step 704, the MS 12 receives information about the BS 10 on the BCCH. The information includes the TSTD mode information. In steps 504 of FIG. 5 and 706 of FIG. 7, the MS transmitter 22 sends the BS receiver 16 the access message on the RACH as shown in FIGs. 2 and 8B. The MS 10 register with the BS 10, MS (i.e., reception mode) by sending access message on the RACH to register with the BS10, and notifies the BS 10 of information about the MS 12 through this registration procedure (See FIG. 8b). The RACH message includes the TSTD mode information.

Then, the BS controller 18 and the MS controller 24 analyze the access message and the broadcast message, respectively, to determine whether a TSTD communication is possible. If such a communication is possible, the BS 10 and the MS 12 perform a traffic channel set-up in step 506 of FIG. 5 and control their respective TSTD transmitter and receiver of FIGs. 3 and 4 in response to TSTD switching pattern control signals determined in a determined operation mode. The determined operation mode will be described in more detail below.

The BS controller 18 analyzes the reception mode of the MS 12 on the RACH in step 604 of FIG. 6, and determines whether a TCH assignment request was received from the MS on the RACH in step 606 of FIG. 6. Upon receipt of a TCH assignment request from the MS 12, the BS controller 18 proceeds to step 608. Otherwise, the BS controller 18 awaits a TCH assignment request on the RACH.

In step 608, upon receiving a TCH assignment request, the BS controller 18 determines whether the TCH can be assigned. If there is an available TCH,

the BS controller 18 assigns the TCH and notifies the MS 12 of a TSTD pattern by sending the MS 12 the message of FIG. 8C on the CCCH. The CCCH message may include the TSTD mode change information and TSTD pattern information. Here, the TSTD mode change information is a field indicating the TSTD mode is changed to a non-TSTD mode when the BS does not want to use the TSTD mode. The TSTD pattern field provides a TSTD pattern in which data is switchedly transmitted through the antennas ANT1 and ANT2 by the BS 10. The TSTD mode change field and the TSTD pattern field are optional.

In step 612, the BS controller 18 determines whether the MS 12 is set to a TSTD reception mode from the reception mode field of the received RACH message. If the MS 12 is in the TSTD mode, the BS controller 18 provides a control signal to the first switch controller 112 based on one of default pattern information, the TSTD pattern information sent to the MS 12 on the CCCH, or pattern information determined by the ESN (Electronic Serial Number) of the MS 12, and sends the TCH in the TSTD mode. Here, it is assumed that there is no TSTD mode change. The first switch controller 112 controls the outputs of the first and second switches 110 and 111 according to the switching pattern control signal received from the BS controller 18 to time-switch the I- and Q-channel data received from the spreader 108 through the antennas ANT1 and ANT 2 as indicated by reference numerals 115 and 117 of FIG. 3. It should be understood that the TSTD pattern is varied according to the switching pattern information.

In step 616, the BS controller 18 determines whether the TCH is released during transmission. If the TCH is released, the BS controller 18 returns to step 606. If the MS 12 is not set to the TSTD reception mode in step 612, the BS controller 18 sends the TCH to the MS 12 in a non-TSTD mode in step 618.

Transmission in the non-TSTD mode implies that the BS controller 18 controls the first switch controller 112 to confine the output of the first and second switch 110, 111 exclusively to the input of the first or second modulator 114 or 116.

Meanwhile, the MS 12 determines whether the TCH assignment request is issued in step 707. Upon generation of the TCH assignment request, the MS controller 24 sends the BS 10 the TCH assignment request message on the RACH in step 708, and receives the CCCH message in step 709 to determine whether the TCH is assigned in step 710. If the TCH is not assigned in step 710, the MS controller 24 returns to step 707.

If the TCH is assigned, the MS controller 24 determines whether the transmission mode of the BS 10 is a TSTD mode or not, in step 712. If the BS 10 is set to the TSTD mode, the MS controller 24 feeds (1) one of a default TSTD pattern information, (2) the TSTD pattern information in the received CCCH message, or (3) the TSTD pattern information determined by its ESN to the second switch controller 212. The second switch controller 212 controls the third and fourth switches 110 and 111 to switch based on the TSTD switching pattern of the BS 10 according to the received control signal. Therefore, the MS 12 controls output of the first and second channel correctors 206 and 208 according to the switching pattern received from the BS 10 to provide continuous I- and Q-channel data streams to a parallel-to-serial converter (PSC) 214. Here, the output of the PSC 214 is deinterleaved by a deinterleaver 216 and recovered to the original data by a decoder 218.

If a handoff occurs between BSs during the TCH transmission, a TCH is assigned again between the new BS and the MS, and the TSTD mode information of the new BS is notified by signalling with the old BS. Therefore,

the TSTD mode control can be implemented despite the handoff. During the handoff, both BSs can transmit in a non-TSTD mode instantaneously even if they support TSTD.

In accordance with the first embodiment of the present invention, if both the BS 10 and the MS 12 support the TSTD, the BS 10 determines to transmit in a TSTD mode, assigns a TCH, and sends a TCH message in the TSTD mode. The MS 12 analyzes a BCCH message and a CCCH message received from the BS 10 and receives the TCH message in the TSTD mode.

The TSTD pattern, that is, a switching pattern between two antennas may be a default pattern, a pattern determined by the ESN of the MS, or a pattern determined by the BS. If there is information to be communicated between the BS and the MS to determine the pattern, the TSTD pattern information can be sent in the TSTD pattern field of the CCCH message of FIG. 8C. If the pattern is determined by the ESN of the MS, the MS preliminarily sends the BS its ESN. If the pattern is determined by the BS, the BS can send its intended pattern to the MS.

The transmission diversity-related message is sent on a forward common channel during a call set-up, and on the forward dedicated control channel during communication on a dedicated channel after the call set-up. To determine a TSTD pattern by the unique number of an MS, the MS sends the BS its unique number like an ESN. If the pattern is determined by the BS, the BS can send its intended pattern to the MS.

If the TSTD is optional to the BS, it should be a requisite to the MS. For better understanding of the operation of forward common and dedicated channels

between these BS and MS, a difference from the mobile communication system having TSTD as an optional function will be focussed on within the scope and spirit of the present invention.

FIG. 1C is a view referred to for describing a TSTD operation method in a mobile communication system having TSTD as a requisite function according to another embodiment of the present invention. Applications of TSTD to forward common and dedicated channels are shown in the drawing. Shaded blocks indicate TSTD aplications.

If TSTD is optional to the BS, it is necessary to notify whether the BS supports TSTD or not via the BCCH. If the MS receives information indicating that the BS transmits in a TSTD mode, it can receive a BS signal in a TSTD mode. While the BS transmits forward common and dedicated channels in TSTD in this system by way of example, TSTD can be applied only to the forward common channels. The MS also receives the forward common channels in TSTD. More specifically, because the forward common channels including the BCCH and the CCCH are shared by all MSs in the coverage area of the BS, the transmission diversity is necessarily applied to them. For accurate synchronization, the MS may receive a TSTD synchronization providing channel from the BS in TSTD by determining whether a TSTD mode is used or not from a BCCH message. Another example of transmitting the synchronization providing channel in TSTD can be found in the case where TSTD is not applied to primary and secondary sync channels used for rapid cell search in an asynchronous mode between BSs and they are sent through a single transmission antenna. The MS produces switching time information for a TSTD mode by use of time information acquired from this synchronization providing channel. TSTD is basically applied to a forward dedicated channel and may be released

when required by the BS or MS or in a handoff. Whether to apply TSTD to the forward dedicated channel is predetermined in the system, or determined by exchanging messages between the BS and the MS on a common control channel during a call set-up and on a dedicated control channel during the call.

As described above, the present invention is related with TSTD services in the cases where a CDMA mobile communication system supports TSTD as optional and requisite.

With TSTD given as a requisite, the transmission diversity can be applied to forward common and dedicated channels since all BSs and MSs can comunicate data in TSTD. TSTD is necessarily applied to the forward common channels. TSTD is basically applied to a forward dedicated channel and may be released when required by the BS or MS or in a handoff.

With TSTD given as optional, TSTD BSs and MSs may coexist with non-TSTD BSs and MSs in the system. In this case, TSTD can be applied to the forward common and dedicated channels in many ways. Since the forward common channel is shared by all MSs in a cell, an MS should be capable of receiving a TSTD signal, especially a TSTD BCCH signal from a BS if the BS can support the TSTD function. In the case of the forward dedicated channel, TSTD is basically applied if both the BS and the MS can support TSTD and may be released when the BS or the MS considers non-TSTD mode communication necessary as in a handoff. If at least one of the BS and the MS does not support the TSTD function, TSTD cannot be applied to the forward dedicated channel.

While a TSTD mode is set up after the BS 10 receives the MS reception mode information on the RACH from the MS 12 in the embodiments of the

present invention, this procedure can be modified. That is, if the MS can accommodate both TSTD and non-TSTD modes, the MS can automatically set its reception mode by analysing the BS transmission mode from a BCCH message received from the BS.

By use of the TSTD operation control procedure according to the present invention, a TSTD device can operate compatibly with a non-TSTD device in a mobile communication system having a TSTD function as optional . When data is transmitted with TSTD, the performance gain of data transmission and reception can be maximized.

In a mobile communication system having TSTD as a requisite function, TSTD is applied to forward common control channels including a BCCH. Thus, the benefit of the TSTD function is maximized.

While the present invention has been described in detail with reference to the specific embodiment, it is a mere exemplary application. Thus, it is to be clearly understood that many variations can be made by anyone skilled in the art within the scope and spirit of the present invention.

WHAT IS CLAIMED IS:

1. A TSTD (Time-Switched Transmission Diversity) controlling method in a mobile communication system having a base station (BS) which transmits forward common and dedicated channel data through at least two antennas, the method comprising the steps of:

sending a message indicating a TSTD/non-TSTD transmission mode by the BS to a plurality of mobile stations (MSs) in the coverage area of the BS through an antenna; and

analysing the message received from the BS and setting a reception mode to a TSTD/non-TSTD mode according to the transmission mode by each MS.

2. The method of claim 1, wherein the forward common channels are a broadcast control channel (BCCH) and a common control channel (CCCH).

3. A TSTD controlling method in a mobile communication system having a BS and a plurality of MSs in the coverage area of the BS, comprising the steps of:

selectively sending forward common channel which includes a message indicating a TSTD/non-TSTD transmission mode in TSTD through at least two antennas by the BS; and

analysing the forward common channel message received from the BS and setting a reception mode to a TSTD/non-TSTD mode according to the transmission mode by an MS in the coverage area of the BS.

4. The method of claim 3, wherein the forward common channel is a BCCH.

5. A TSTD controlling method in a mobile communication system which includes a BS for transmitting on forward BCCH, CCCH, and TCH (traffic channel) and a plurality of MSs for transmitting on a reverse access channel, comprising the steps of:

sending a broadcast message indicating a transmission mode on the BCCH to the MSs by the BS;

sending the BS an access message indicating a reception mode on the reverse access channel in response to the broadcast message by the Mss; and

sending traffic channel data in TSTD by the BS if the reception mode information received on the reverse access channel indicates a TSTD mode.

6. The method of claim 5, wherein the BCCH and the CCCH are sent through at least one antenna.

7. A TSTD controlling device in a mobile communication system which includes a BS and an MS which have at least two different channels and communicate a control message on the channels, comprising:

a BS device having a controller for generating a switching control signal having a specific pattern when an MS reception mode is a TSTD mode, to transmit data in TSTD by sequentially switching at least two antennas without an overlap in time; and

an MS device having a reception switch for switching in response to the switching control signal when a BS transmission mode is a TSTD mode.

8. The device of claim 7, wherein the specific pattern is determined by the unique number of the MS.

9. The device of claim 8, wherein the specific pattern is a switching

pattern determined by the BS and the MS determines a reception switching pattern by receiving the switching pattern on a common control channel.

10. The device of claim 7, wherein the BS device further includes a transmitter for transmitting a message indicating a transmission mode on a BCCH which is used to send common information to a plurality of MSs.

11. The device of claim 7, wherein the MS device sends the BS reception mode information on a reverse access channel when the MS detects TSTD information from the broadcast message received from the BS on a common control channel.

12. The device of claim 7, wherein the BS device sets a TSTD mode for the transmitter according to the message indicating the MS reception mode received on the reverse access channel.

13. A TSTD controlling device in a mobile communication system having a TSTD function, comprising:

a BS device for transmitting a forward common channel in TSTD; and
an MS device for receiving the forward common channel in TSTD.

14. The device of claim 13, wherein the forward common channel is a broadcast channel.

15. The device of claim 13, wherein the forward common channel is a synchronization providing channel.

16. A TSTD controlling method in a mobile communication system

having a TSTD function, comprising the steps of:

transmitting a forward common channel including a BCCH and a forward dedicated channel in TSTD by a BS; and

receiving the forward channels in TSTD by an MS.

17. The method of claim 16, wherein the forward common channel is a synchronization providing channel.

18. The method of claim 16, further comprising the step of not sending the forward dedicated channel in TSTD by exchanging control messages between the BS and the MS.

19. The method of claim 16, further comprising the step of sending the BS a control message on a reverse control channel by the MS, requesting that transmission of the forward dedicated channel in TSTD should be stopped.

20. The method of claim 16, further comprising the step of sending the MS a control message on a forward control channel by the BS, indicating that the TSTD transmission of the forward dedicated channel is stopped.

21. A signal reception method in an MS of a mobile communication system, comprising the steps of:

determining whether a BS transmits in a TSTD transmission mode by analysing a signal received from the BS; and

receiving a signal from the BS in a TSTD reception mode if the signal is sent in the TSTD transmission mode.

22. The method of claim 22, wherein the signal received from the BS

is a common channel signal.

23. The method of claim 22, wherein the common channel is a synchronization providing channel.

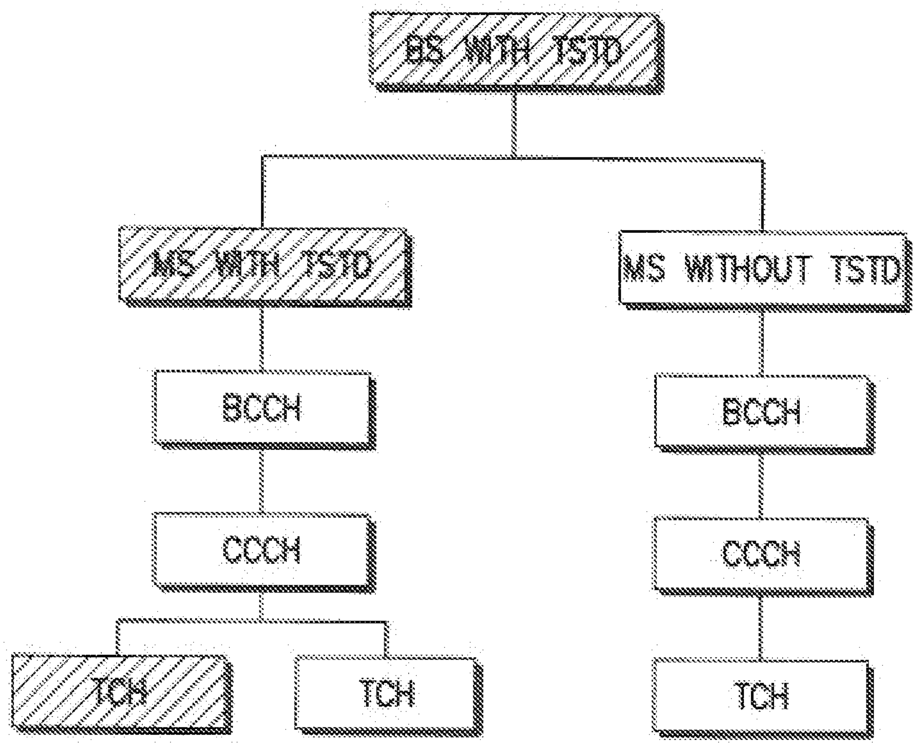

BS WITH TSTD
MS WITH TSTD
MS WITHOUT TSTD
BCCH
BCCH
CCCH
CCCH
TCH
TCH
TCH

FIG. 1A

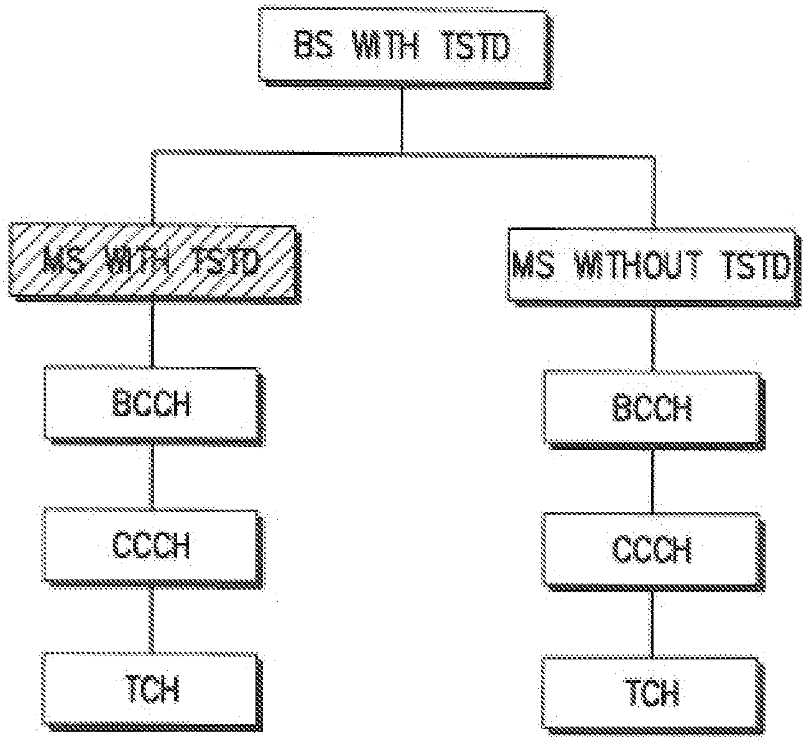

BS WITH TSTD
MS WITH TSTD
MS WITHOUT TSTD
BCCH
CCCH
TCH
BCCH
CCCH
TCH

FIG. 1B

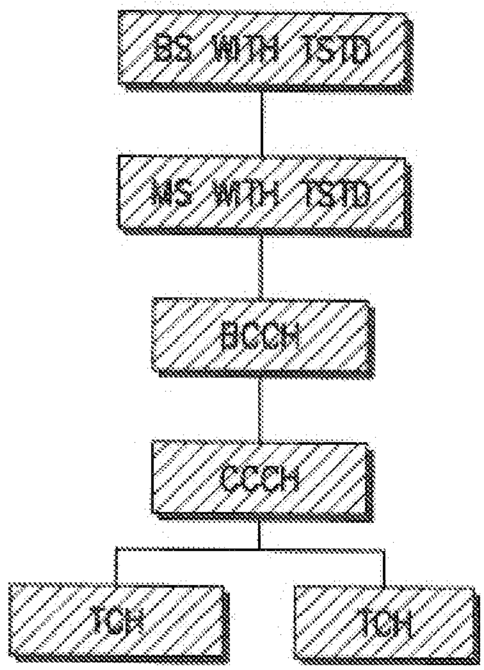


FIG. 1C

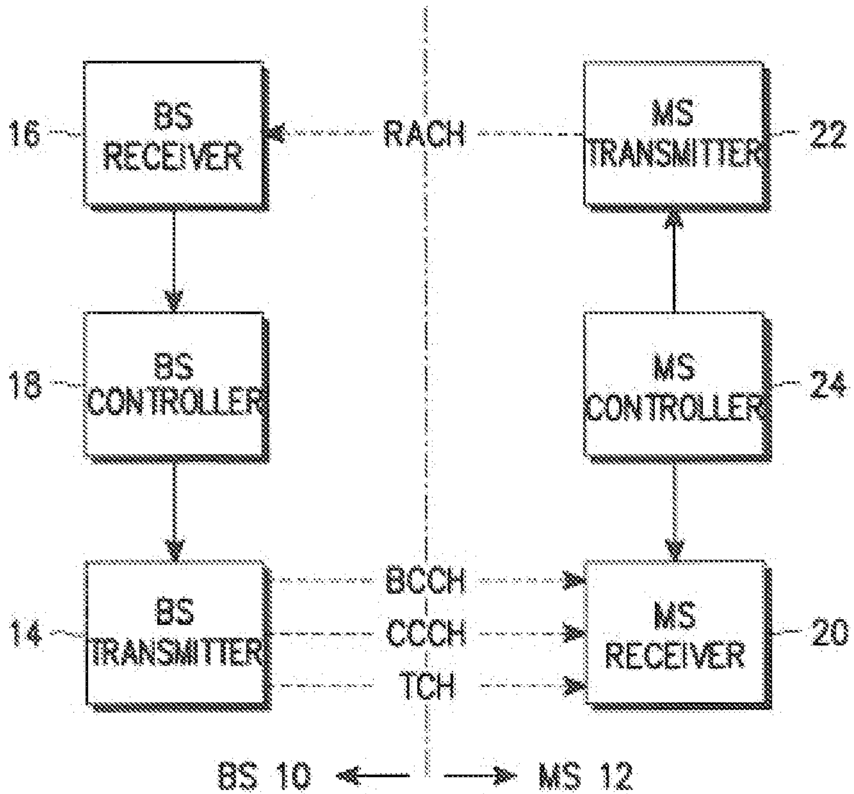

BS RECEIVER
16
RACH
MS TRANSMITTER
22
BS CONTROLLER
18
MS CONTROLLER
24
BS TRANSMITTER
14
BCCH
CCCH
TCH
MS RECEIVER
20
BS 10
MS 12

FIG. 2

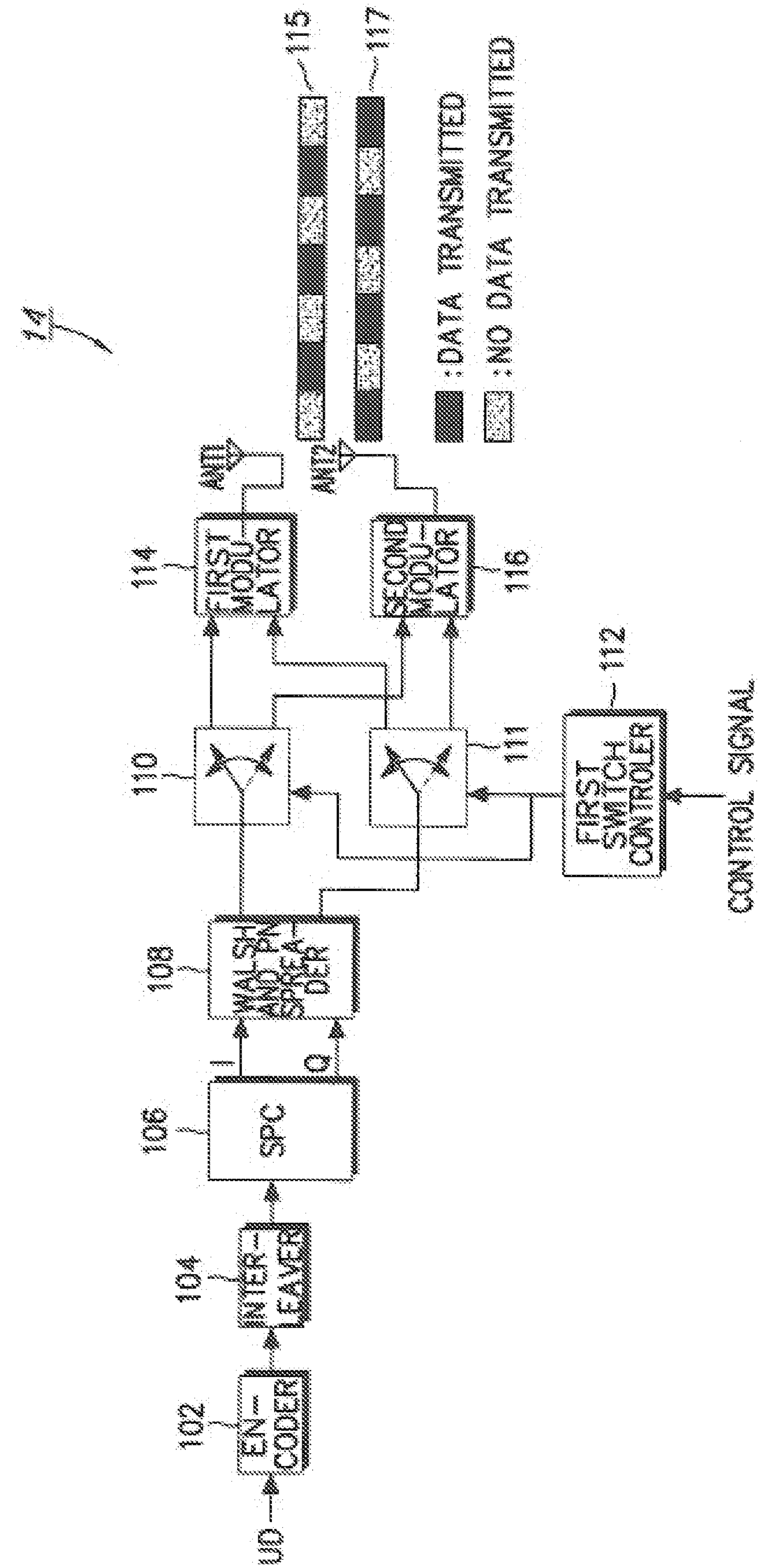

14
UD
102
EN-CODER
104
INTER-LEAVER
106
SPC
I
Q
108
WALSH AND PN SPREADER
110
111
112
FIRST SWITCH CONTROLER
CONTROL SIGNAL
114
FIRST MODU-LATOR
116
SECOND MODU-LATOR
ANT1
ANT2
115
117
:DATA TRANSMITTED
:NO DATA TRANSMITTED

FIG. 3

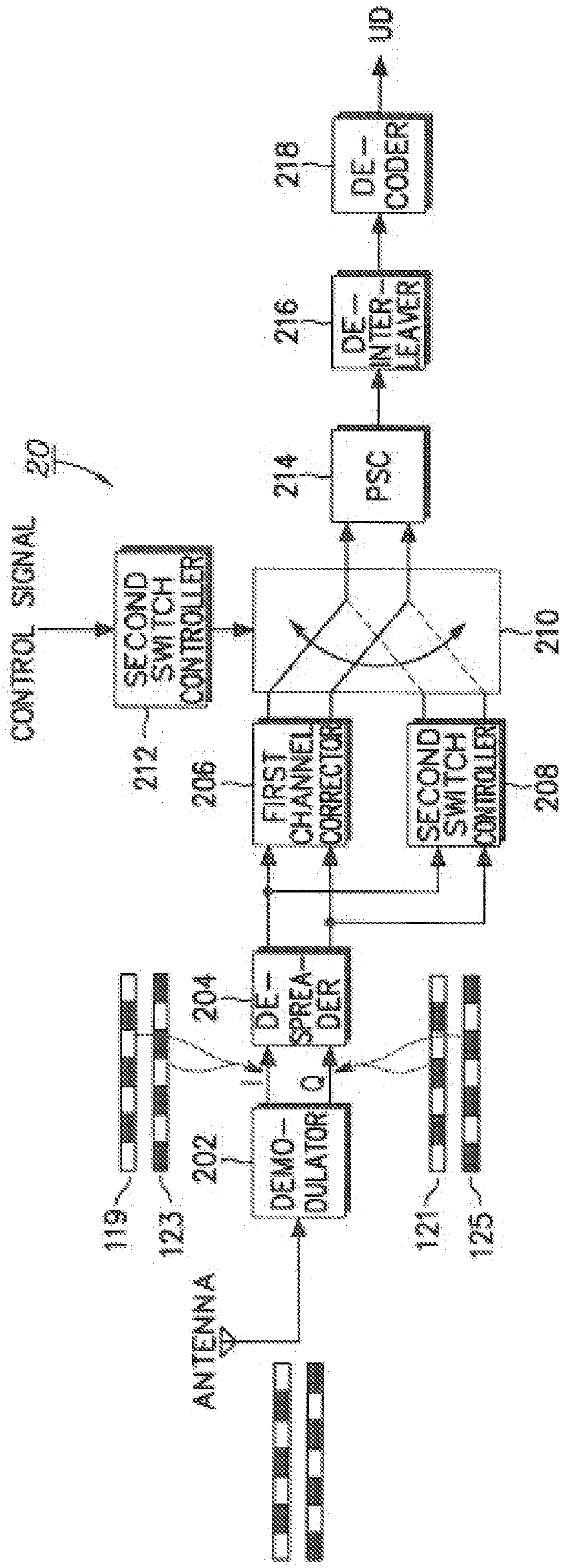

ANTENNA
119
123
121
125
202
DEMO-
DULATOR
I
Q
204
DE-
SPREA-
DER
206
FIRST
CHANNEL
CORRECTOR
208
SECOND
SWITCH
CONTROLLER
CONTROL SIGNAL
212
SECOND
SWITCH
CONTROLLER
210
20
214
PSC
216
DE-
INTER-
LEAVER
218
DE-
CODER
UD

FIG. 4

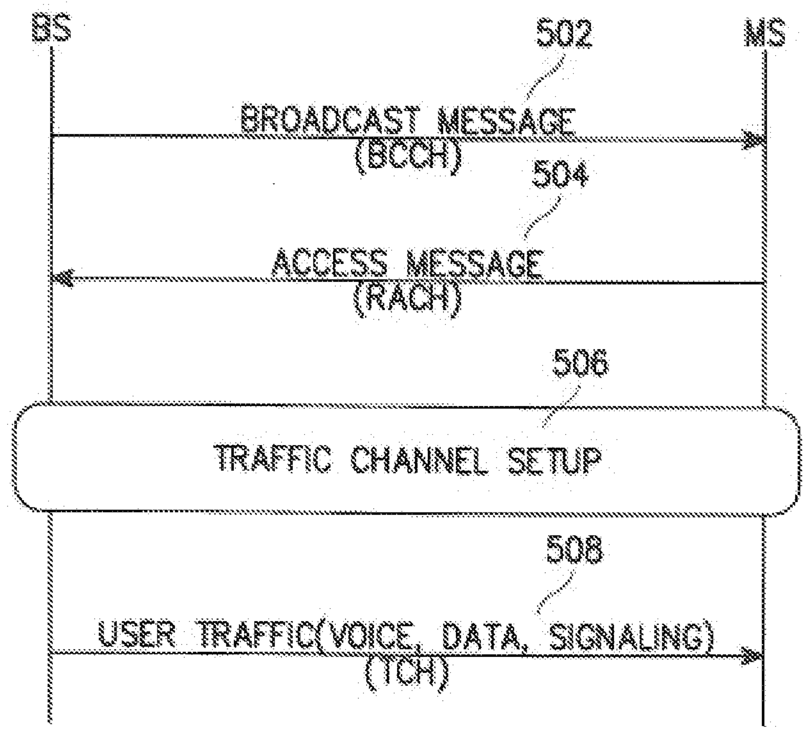

BS
MS
502
BROADCAST MESSAGE
(BCCH)
504
ACCESS MESSAGE
(RACH)
506
TRAFFIC CHANNEL SETUP
508
USER TRAFFIC(VOICE, DATA, SIGNALING)
(TCH)

FIG. 5

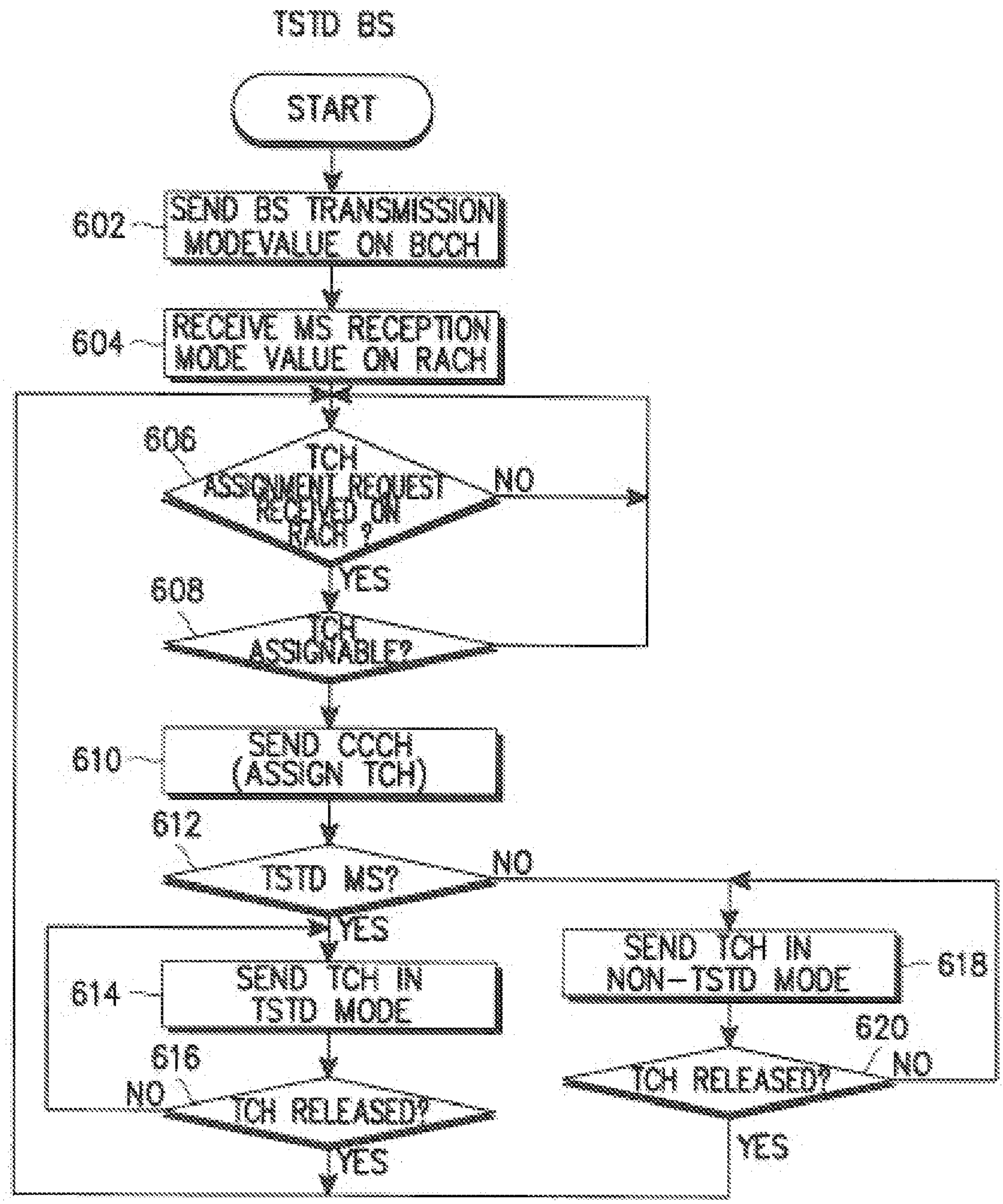

TSTD BS
START
SEND BS TRANSMISSION MODEVALUE ON BCCH
602
RECEIVE MS RECEPTION MODE VALUE ON RACH
604
606
TCH ASSIGNMENT REQUEST RECEIVED ON RACH ?
NO
YES
608
TCH ASSIGNABLE?
SEND CCCH (ASSIGN TCH)
610
612
TSTD MS?
NO
YES
SEND TCH IN TSTD MODE
614
616
NO
TCH RELEASED?
YES
SEND TCH IN NON-TSTD MODE
618
620
TCH RELEASED?
NO
YES

FIG. 6

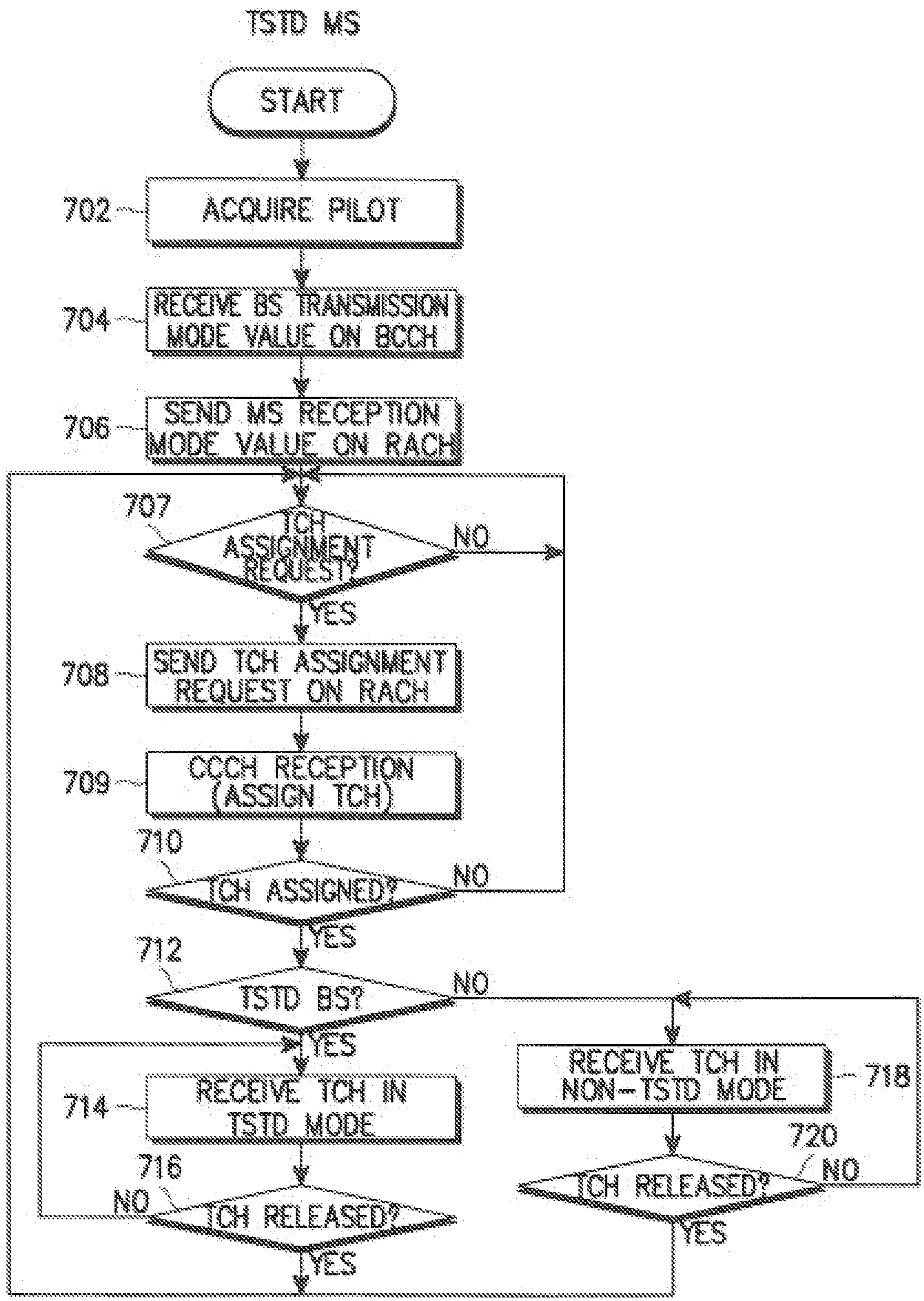

TSTD MS
START
702
ACQUIRE PILOT
704
RECEIVE BS TRANSMISSION MODE VALUE ON BCCH
706
SEND MS RECEPTION MODE VALUE ON RACH
707
TCH ASSIGNMENT REQUEST?
NO
YES
708
SEND TCH ASSIGNMENT REQUEST ON RACH
709
CCCH RECEPTION (ASSIGN TCH)
710
TCH ASSIGNED?
NO
YES
712
TSTD BS?
NO
YES
714
RECEIVE TCH IN TSTD MODE
716
NO
TCH RELEASED?
YES
718
RECEIVE TCH IN NON-TSTD MODE
720
TCH RELEASED?
NO
YES

FIG. 7

BROADCAST MESSAGE FORMAT

MESSAGE TYPE	BS TRANSMISSION MODE	OTHER INFORMATION ELEMENTS

FIG. 8A

ACCESS MESSAGE FORMAT

MESSAGE TYPE	MS RECEPTION MODE	OTHER INFORMATION ELEMENTS

FIG. 8B

CCCH MESSAGE FORMAT

MESSAGE TYPE	TSTD MODE CHANGE (OPTIONAL)	TSTD PATTERN (OPTIONAL)	OTHER INFORMATION ELEMENTS

FIG. 8C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 99/00238

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6]: H 04 B 7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[6]: H 04 B 7/04, 7/06; H 04 L 1/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A X	CH 682 195 A5 (ASCOM TECH) 30 July 1995 (30.07.95), fig.1-3; abstract;page 2, lines 5-9; page 3, line 51 - page 4, line 30.	1,3,5,7,14,16,21 13
A	WO 96/08 908 A2 (INTERDIGITAL TECHNOLOGY CORP.), 21 March 1996 (21.03.96), claim 1.	1,3,5,7,13,16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
„A" document defining the general state of the art which is not considered to be of particular relevance
„E" earlier application or patent but published on or after the international filing date
„L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
„O" document referring to an oral disclosure, use, exhibition or other means
„P" document published prior to the international filing date but later than the priority date claimed
„T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
„X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
„Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
„&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 July 1999 (22.07.99)	03 August 1999 (03.08.99)

Name and mailing adress of the ISA/AT	Authorized officer
Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna Facsimile No. 1/53424/200	Dröscher Telephone No. 1/53424/320

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 99/00238

Im Recherchenbericht angeführtes Patentdokument / Patent document cited in search report / Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung / Publication date / Date de publication	Mitglied(er) der Patentfamilie / Patent family member(s) / Membre(s) de la famille de brevets	Datum der Veröffentlichung / Publication date / Date de publication
CH A 682195	30-07-1993	DE A1 4219677	04-02-1993
WO A2 9608908	21-03-1996	AU A1 44620/96	29-03-1996
		EP A2 779991	25-06-1997
		FI A0 970953	06-03-1997
		FI A 970953	14-04-1997
		JP T2 10509287	08-09-1998
		US A 5614914	25-03-1997
		WO A3 9608908	23-05-1996
		US A 5663990	02-09-1997
		US A 5859879	12-01-1999